Agricultural Management: Climate Change Preparedness

- Policy Guidance
    - *Boulder Resiliency Plan (draft, 2016)*
    - *Colorado Climate Change Vulnerability Study (2015)*
    - *Boulder County Climate Change Preparedness Plan (2012)*
    - *Boulder's Climate Commitment (draft, 2016)*
    - *Boulder Valley Comprehensive Plan*
    - *Boulder Climate Workshop (in progress, 2016)*
    - *Colorado Water Plan*
- Existing Conditions
    - *Past*
        - *CO_2 increasing*
        - *Temperatures rising*
        - *Recent large disturbance events that climate change may contribute to*
            - *2002 drought*
            - *2010 4-mile canyon fire*
            - *2013 front range floods*
    - *Future*
        - *High confidence*
            - *More CO_2*
            - *2-6 F warming by 2050*
            - *More heat waves*
            - *Earlier snow melt*
        - *Medium confidence*
            - *More drought*
            - *More heavy precipitation*
            - *More wildfire*
            - *Bigger snow storms*
        - *Unknown/Low confidence*
            - *Annual precipitation*
            - *Tornadoes and hail storms*
    - *Potential effects to Agricultural Productivity and Management*
        - *Rising atmospheric CO_2*
            - *Decreasing time b/w germination and plant maturity, reducing yields*
            - *C3 crops (small grain cereals) show positive yield response to increase atmospheric CO_2 – but protein dilution*
            - *Forage crops will have higher C: N ratios*
            - *Some weeds are especially responsive to CO_2*
                - *Herbicide efficacy decreases with increased atmospheric CO_2*

        - *High CO_2 reduces nutritional quality*
- *Increased temperatures*
    - *Hot temperatures late in the growing season may reduce (or require cooling with irrigation)*
    - *High temperatures negatively affect flowering, grain set and yield*
    - *High temperatures stress plants and activation of heat shock proteins can change shifts in composition of proteins in cereal grains—affecting baking quality*
    - *Warm temperatures in winter can affect winter hardiness of perennial forage species*
    - *Expanding growing season length may increase susceptibility to frosts*
    - *Precipitation is coming as rain instead of snow – implications for water rights - timing and quantity of available water*
- *Pest and disease outbreaks:*
    - *Increases to pest survival due to warm overnight temperatures and more susceptible plants, due to drought stress; could lead to more chemical use*
    - *Shifts in ranges of insects, leading to increased populations of marginally-overwintering species*
    - *Greater ranges of pests not currently present in Colorado*
    - *Additional generations by traditionally univoltine insects*
- *Changing weather patterns*
    - *Extreme events (heat, cold, precipitation, hail) can physically damage crops and wash away soil, seeds, or plants*
    - *Higher volume rain events*
        - *Delayed plantings or harvest*
        - *Increased susceptibility to root diseases*
        - *Increased soil compaction*
- *General uncertainty how increases in temperature, variable weather, increased CO_2 will all combine together to affect agriculture (which one will be the main driver)*
- *Change in location and scale of agricultural operations*
- *Increased crop water use with decreases in water availability and storage*
- *Irrigated hay fields -> pasture or native grasslands*
- *Conflict between water for irrigated agriculture and aquatic and riparian habitats.*
- *Grazing*
    - *Increase length of forage production season, but may reduce forage quality (high CO_2 reduces nutritional quality)*
    - *"Lengthening growing seasons; however, could reduce the need to accumulate winter forage."*
    - *Water and drought both affect forage*
    - *C3 and C4 grasses*
- *Interacting drivers*

        - *Population growth*
        - *Energy availability*
        - *Economic vitality*
        - *Shifting demographics*
        - *Land use*
- Objective(s)
    - *Prepare for climate change by identifying agricultural management practices in response to increased aridity.*
    - *Research the potential for agricultural practices to mitigate climate change.*
- Management Strategies/Criteria/ Processes/ Examples (if applicable)
    - *Develop a Water Strategy*
        - *Increase efficiency of water distribution, but be aware that flood irrigation is an important part of groundwater recharge and the support of wetland habitats on OSMP. Establish criteria, working with lessee input, on ditch lining*
            - *Earthen ditch -> lined ditch*
            - *Surface flood -> sprinkler*
        - *Increase water storage*
        - *Water use by plants (crops and varieties)*
        - *Get more water for irrigation*
        - *Prioritize water to fields that need it the most*
        - *Water banking and storm water retention*
    - *Grazing*
        - *De-stocking: protocol, and irrigated hayfield -> pasture (see Grazing the Native Grasslands)*
        - *Prescriptive Grazing / Grazing as an ecological management tool that has sensitivities to climate/drought variability (see Grazing in Native Grasslands)*
        - *Incorporate climate into the Rangeland Condition Assessments*
    - *Farmers*
        - *Increase the flexibility of agricultural management techniques*
            - *Rotation, water use*
        - *Survey of farmer's views on climate change impacts and strategies they might adopt*

- Measures of Success
    - *Climate Change Preparedness strategies "in place" /ready to be implemented.*
        - *Water strategy*
        - *De-stocking protocol*
        - *Rangeland Condition Assessment protocol and monitoring*
    - *Research conducted/ findings.*

- Research Opportunities
    - *Mitigating GHG emissions with agriculture: Soil carbon sequestration; Soil respiration*

- *New types of agriculture*
- *New crop varieties and species*
- *New dryland and low-water commodity crops and forage species*
- *Crop diversity and crop system resilience*
- *Experimental drought / stress tests*
- *Water sharing*